



NASA ASTROBIOLOGY INSTITUTE ANNUAL REPORT YEAR



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Project Report: Delivery of Organic Materials to Planets

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Executive Summary

Since Gerard Kuiper's discovery of a methane atmosphere around Titan, the largest and brightest of Saturn's satellites, Titan has attracted a great deal of exobiological interest. Titan provides us with a planet-sized laboratory for testing the synthesis of organic compounds in a nearly neutral redox environment, over large spatial scales, both with and without liquid water. These natural chemical experiments could be ongoing today, and the products of such experiments in localized regions of elevated temperatures would be well preserved under the ambient 95 K (–178°C) temperature and high atmospheric densities that shield the surface from destructive radiation.

The Cassini–Huygens mission will make a complete inventory of Titan's surface from a variety of remote sensing and in situ techniques from late 2004 through late 2008. The Huygens atmospheric probe will descend to the surface in January 2005. Before and after the atmospheric probe's landing, the Orbiter will undertake some 45 close flybys of Titan. The result of the Cassini–Huygens mission will be a level of understanding of the geology, geodesy, atmospheric physics and surface–atmosphere interactions on Titan rivaling that for Mars after the Mars Global Surveyor (MGS) (with the exception of a lack of a detailed global altimetric map of the body). Further, Cassini–Huygens will provide us with information regarding the distribution and nature of any organics spread across the Titan surface. Should there be surface compositional variations in the organics, especially if correlated with apparent geologic activity or crustal melting, the interest in returning to Titan in order to sample those interesting places directly, for signs of oxygen-bearing organics like amino or carboxylic acids, for example, will be high.

Indeed, NASA has already expressed interest in initial planning for a post–Cassini mission to Titan, and it appears likely that such a mission will be high on the list of astrobiologically interesting programs in the planetary decadal strategy now being prepared. It has become standard operating procedure for the NAI to play a key role in mission planning for astrobiologically interesting targets partly or wholly through conduct of focus groups. The Mars and Europa groups have been very effective in this regard. It is natural, then, that a similar effort be undertaken for Titan, and the timing is appropriate, given NASA's interest in post–Cassini mission planning, and the imminent arrival of Cassini–Huygens at Saturn.

The Titan Focus Group is open to all interested parties, but each individual who desires to participate is asked to identify themselves, their institution, and

to commit to a certain amount of time and activity. Hence casual chat room browsers are discouraged. Most of the work of the group is by e-mail, but two or three meetings of the focus group organized around convenient ancillary meetings (such as the NAI annual meeting) are conducted. Quarterly reports of the focus group progress are submitted to the NAI by direct (telecon) presentation backed up by written material. The final product of the focus group will be a series of four white papers organized around the four themes discussed in the following paragraph. These will be appropriate raw material around which the NAI can generate a set of recommendations to NASA for a follow-on mission to Titan, for the experimental techniques and technologies to be used, for the motivating questions to be addressed by the mission, as well as pointers to preliminary Cassini results that would influence the timing and scoping of such a mission.

The four topical areas that shape the four white papers are staggered in time over the 3 years of the Titan Focus Group (TFG), and are organized in a logical intellectual order. The TFG is first considering the questions that motivate the astrobiological exploration of Titan, and will generate a sharply focused set of scientific questions and objectives that will constrain the kinds of techniques to be applied post-Cassini. Once this is accomplished, the TFG will move into the phase of considering the techniques that should be used in the exploration of Titan beyond Cassini-Huygens, with a focus on the analysis of the organic chemistry of the surface. The effort is constrained by the results of a number of recent experimental studies. Experimental organic chemists, and not merely "Titanophiles," are involved in the TFG to ensure that this second topic reaches a realistic conclusion. The third topic depends on the successful completion of the second. It concerns the types of missions to be conducted after Cassini-Huygens, as well as the types of analyses of Cassini-Huygens data required to constrain the next mission. Hence science payloads will be considered and winnowed down into a prioritized list, recommendations on the number and types of sampling sites will be made, and there will be explicit discussion of how Cassini-Huygens data should be used to decide on the timing and scope of the mission, as well as potential landing sites. Finally, as Cassini-Huygens begins its observations of Titan, the TFG will shift its attention to considering the early results from the first eight flybys of Titan, and the Probe mission. Enough data will be released in real time or rapidly after each encounter to enable the TFG to make a preliminary assessment of the nature of Titan's surface from the point of view of the astrobiology questions formulated in the first year of the TFG's existence. The TFG will also begin the process of assessing post-Cassini mission feasibility and landing site potentials based on the Cassini data returns.

In addition to the Cassini mission itself, the TFG will have access to mission design capabilities at JPL. These capabilities would be exercised in the first half of 2004, when the TFG is considering post-Cassini mission scenarios.

A graphical plan for the TFG is appended to the end of this report.

[Focus Group Description & Activities](#)

The TFG was approved by the NAI this past spring for a formal start in

November 2002. A pre-start meeting was held at NASA Ames Research Center during the NAI Annual Meeting, at which the purpose of the group and its schedule were discussed. Signup of participating scientists began at the meeting and continues by e-mail.

Highlights

- The Titan Focus Group has been created.

Roadmap Objectives

- [Objective No. 3: Models for Life](#)
- [Objective No. 7: Extremes of Life](#)
- [Objective No. 17: Planetary Protection](#)
- [Objective No. 5: Linking Planetary Biological Evolution](#)
- [Objective No. 9: Life's Precursors Habitats](#)

Mission Involvement

Mission Class*	Mission Name (for class 1 or 2) OR Concept (for class 3)	Type of Involvement**
1	Cassini	IDS, Science Team Leader, co-I's, etc.

* Mission Class: Select 1 of 3 Mission Class types below to classify your project:

1. Now flying OR Funded & in development (e.g., Mars Odyssey, MER 2003, Kepler)
2. Named mission under study / in development, but not yet funded (e.g., TPF, Mars Lander 2009)
3. Long-lead future mission / societal issues (e.g., far-future Mars or Europa, biomarkers, life definition)

** Type of Involvement = Role / Relationship with Mission

Specify one (or more) of the following: PI, Co-I, Science Team member, planning support, data analysis, background research, instrument/payload development, research or analysis techniques, other (specify).

In the fourth phase of the TFG participants will analyze publicly released Cassini-Huygens data to assess appropriate surface sites, and mission designs, for the astrobiological exploration of Titan's surface.